

1951

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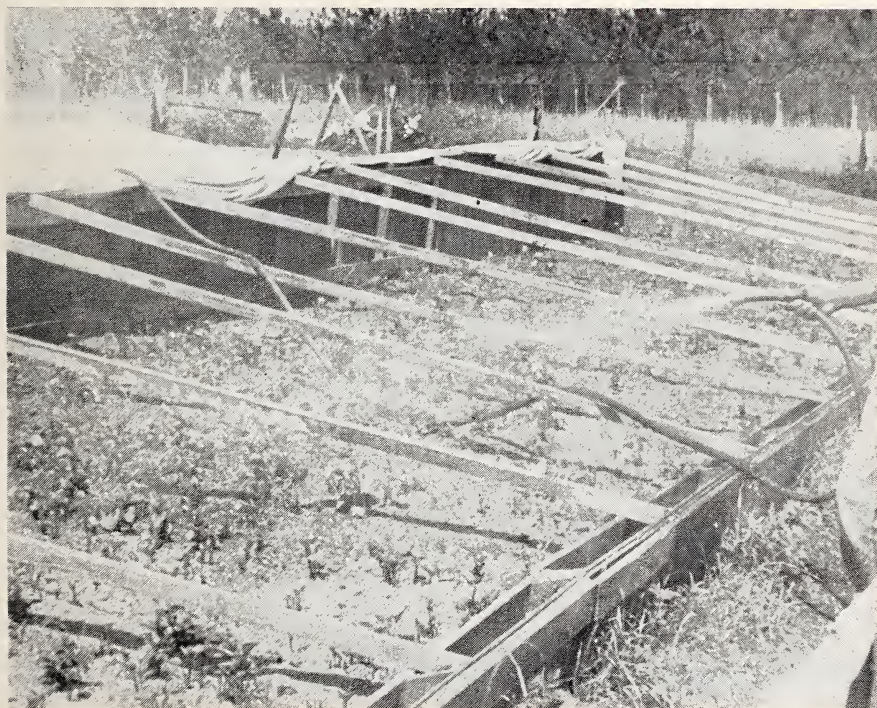
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SWEET POTATO HOTBEDS for LOUISIANA

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SWEET POTATO HOTBEDS FOR LOUISIANA

WILEY D. POOLE, AGRICULTURAL ENGINEER

Farmers are aware of the importance of setting out sweet potato plants just as soon as possible after the danger of a late frost has passed. Having early plants available for field setting has many times resulted in additional cash returns to the farmer, wherein he was able to harvest early and take advantage of a higher price paid for early potatoes. In general, the ability to produce early plants has enabled the farmer to enjoy a longer growing season, and harvesting can be completed before the rainy season in the fall.

With the exception of the most southern part of the sweet potato area of Louisiana, it is advisable to utilize some type of hotbed for producing sweet potato plants large enough for field setting after danger of late frosts. In this bulletin consideration will be given to the most suitable location and types of hotbeds as well as the means for heating them under Louisiana's climatic conditions.

LOCATION OF THE HOTBED

Hotbeds should always be located on a well-drained site that is free from low spots and which will not flood during heavy rains. A location near the house where the beds can be given frequent attention is desirable. The artificial heat supplied to the hotbed is a supplement to the heat supplied by the sun; therefore, the hotbed should be located so as to be exposed to the sun as much as possible and also protected from the north wind. In locating the hotbed consideration should be given to the convenience of getting water piped to the bed, and gas or electricity if either is to be used as a source of heat.

SIZE OF HOTBED

Figure 6 shows three typical sizes of hotbeds which are laid out to use most economically the standard lengths of electric heating cable kits. Some of the larger commercial plant growers prefer the wider hotbed as shown in Figure 8. The size and number of hotbeds needed by the farmer will depend upon the acreage to be planted as well as the method used for planting this acreage. A small acreage might be planted with slips from the hotbed or a larger acreage may be planted from vine cuttings taken from early hotbed slips which were planted in the field. In determining the size of hotbed desired it should be remembered that approximately 12,500 plants are needed to set one acre of sweet potatoes on rows $3\frac{1}{2}$ feet apart when the plants are spaced about 12 inches apart in the row.

Table 1 gives the number of plants needed to plant one acre for various row widths, as well as plant spacings of 8, 12, 18 and 24 inches.

TABLE I. Number of Plants Required for Setting Out an Acre of Sweet Potato Plants for Various Row Widths and Spacing of Plants on the Row

| Row Spacing | Spacing of Plants on the Row (in inches) | | | |
|-------------|--|-----------|-----------|-----------|
| | 8 inches | 12 inches | 18 inches | 24 inches |
| 36 inches | 21,800 | 14,520 | 9,680 | 7,260 |
| 42 inches | 18,700 | 12,444 | 8,296 | 6,222 |
| 48 inches | 16,350 | 10,890 | 7,260 | 5,445 |
| 54 inches | 14,666 | 9,680 | 6,453 | 4,840 |
| 60 inches | 13,200 | 8,712 | 5,808 | 4,356 |

Results of various investigations indicate that for hotbed setting small roots will produce more plants than the larger roots. Edmond and Dunkelberg (2)¹ found that by crowding the roots in the hotbed a substantial increase in the number of plants per unit area resulted. This also appreciably reduced the labor and heat requirements per given number of plants. Therefore, to get the most out of the hotbed space it is recommended that as many roots as possible be placed in the bed, having each root placed as close to the adjacent root as possible without touching. Not allowing the roots to touch is a precaution to prevent rotting; however, research data indicate that roots' touching in the hotbed will not increase rotting if the seed stock is healthy and free from disease to start with.

A bushel of U. S. No. 1 seed sweet potatoes will generally produce in a hotbed 2000 to 2500 plants from a total of three or four pullings. A bushel of U. S. No. 1 seed potatoes will occupy about 15 square feet of hotbed space.

MATERIALS FOR CONSTRUCTING THE HOTBED

The Frame—A well constructed hotbed frame should be free of cracks which might let the heat escape. The cover should fit snugly to the frame on all sides. A suitable frame can be built of lumber 1 inch thick having the main supporting members made of 2" x 4" battens and stakes. If the bed is to be used for several seasons, then the lumber should be of a type such as cypress or cedar which will withstand the weather. Figure 7 shows a cross section of a typical hotbed 6 feet wide and having sides made of lumber. This type of hotbed is designed to use either glass sash or cloth as a cover. The suggested lengths for this type of hotbed when using electric cable for heating are shown in Figure 6. For a more permanent installation the sides and ends of the hotbed can be made of brick, concrete block or similar long lasting materials. There are a number of these types of hotbeds in Louisiana operated by large commercial plant growers. These beds are usually 10

¹ Numbers in parentheses refer to literature cited, Page 24.

feet wide and have a gable type of cover framing as shown in Figures 1 and 8. The length of the hotbeds when using hot water is usually 60 feet. It is not necessary to excavate below the ground surface in building the artificially heated hotbeds. This frame should be laid out on a well-drained, fairly level spot. If the location is on a slight slope a drainage ditch should be dug on the uphill side to prevent rain water from entering the bed. Figure 7 shows a cross section of a hotbed and the drainage ditch on the uphill side.

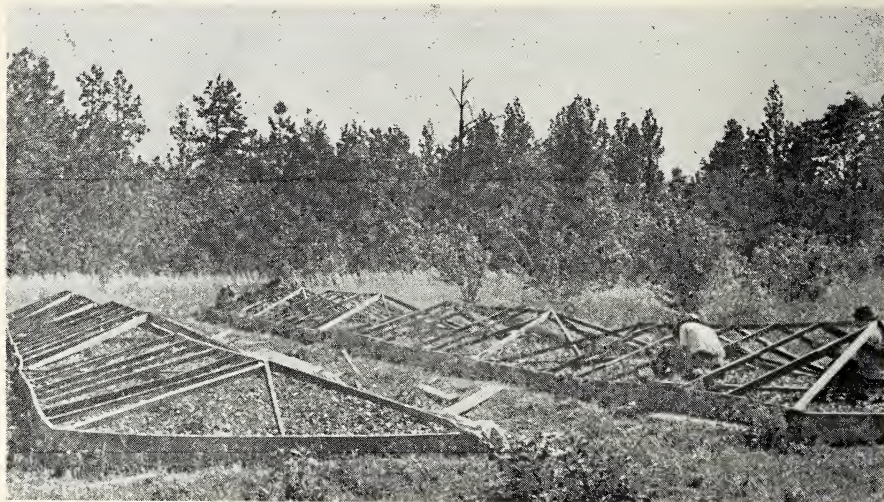


FIG. 1—Wide Gable-framed Hotbed.

The Cover—Hotbed covers may be of glass sash, glass substitute fabric, treated heavy muslin or similar material. Of these covers the glass sash has probably been used more extensively than any other type. This is primarily because of its long lasting quality and ease of handling. The standard glass sash is 3 feet wide and 6 feet long. Glass substitutes, such as Sunray cloth and Sunray glass, have become increasingly popular lately because of a much lower cost than glass sash. In testing glass substitutes, Zahour (1) reported that clear cellulose acetate film appeared better than glass for sash glazing as the cellulose film showed a lower heat consumption and wider transmission of solar rays, resulting in a more uniform temperature and humidity essential for normal plant growth.

Heavy cloth covers are used extensively in the South on large installations of sweet potato hotbeds. Experiments conducted by engineers of the Louisiana State Agricultural Experiment Station showed that under Louisiana conditions, when comparing glass sash and cloth cover, the cloth cover produced plants at a slightly lower consumption of heat but the glass sash produced plants slightly earlier than the cloth covered hotbeds. Cloth covers must be well fastened to the hotbed frame to prevent the wind from whipping the fabric loose. Some

type of pole should be fastened to the lower end of the cloth cover to keep it weighted down. This pole attached to the lower end of the cover will facilitate easier handling of the cover when rolling it back for sunning the beds. Non-transparent coverings must be rolled back during the day to let the sunlight reach the plants after they sprout.

Insulation—Because of the reasonably mild weather during the period of operating the sweet potato hotbeds, the use of commercial insulation of these hotbeds is not recommended. However, the use of insulating materials such as pine straw, sawdust, chopped corn cobs and chopped hay which are obtainable around the farm at no additional cost, is recommended. Ordinarily, heat loss through the soil under the hotbed is small as compared to the losses through the sash and frame. Research studies were conducted to determine to what extent the heat consumption of a hotbed could be reduced by utilizing from 3 to 4 inches of farm waste material such as pine straw, chopped hay or cornstalks, or wood shavings under the heating cables or pipes in the hotbed. Results of these experiments showed that when using such insulation an average saving in heat consumption as great as 15 to 20 per cent could be expected. This insulating layer is shown in the cross section drawing of a hotbed in Figures 7 and 8.

It is also recommended that farm waste insulating material as mentioned in the above paragraph be piled around the outside ends and sides of the hotbed to give further protection from the cold air. All cracks in the hotbed should be sealed tight to prevent leakage.

Bedding Media—A sandy loam type of soil has been used more extensively than any other material for bedding down sweet potatoes in the hotbed. Sand and sawdust are sometimes used but if no additional plant food is to be added to the bedding media, it is recommended that a sandy loam soil be used. Edmond and Dunkelberg (4) found that when comparing soil and sand as a bedding media, little difference, if any, existed in total plants produced when equal amounts of commercial fertilizer were added. However, a great deal of difference in favor of soil existed when soil alone and sand alone were compared. It would then seem that the most influential factor in the bedding media for producing plants is the plant food present. Therefore, it is recommended that commercial fertilizer be added to and thoroughly mixed with the bedding media to increase plant production of the hotbed. The rate of application should be approximately 350 pounds of 5-10-5 per acre, which would be one pound of fertilizer spread over 124 square feet of hotbed surface.

If a fine loam soil is used as a bedding media there is danger of a crust forming from frequent watering. To prevent this it is recommended that a layer of 1 to 2 inches of sawdust or sand be placed on top of the bedding soil. To prevent moving or disturbing the mother potato when pulling slips, a layer of poultry wire should be placed over the entire bed after the sweet potatoes are placed in the hotbed. The location

of the poultry wire, sawdust, etc., is shown in the cross section view of a standard hotbed in Figures 7 and 8.

METHODS OF HEATING HOTBEDS

Many research workers have conducted experiments to determine the optimum temperature to hold the sweet potato hotbeds for the most economical plant production. It is generally considered that the temperature of the potato should be between 80° F. and 85° F. Edmond and Dunkelberg (2) narrowed this range down to 83° F. to 85° F. The more closely the optimum temperature is maintained within a sweet potato hotbed the greater will be the efficiency of plant production. In south Louisiana it is a common practice to depend upon field setting for plants. However, adverse weather conditions such as cold rains or a late cold spell render this practice very uncertain for the very early slips. Table II gives the average minimum temperature for the various sweet potato areas of Louisiana during the three months in which sweet potato plants are being grown for field setting. It is obvious that these temperatures are far below the recommended temperature for favorable plant growth. In several areas of the state some use is being made of hotbeds without any source of heat other than the sun's rays during the day. The hotbed frame and cover are the same as that of the heated type. During cold spells or cool nights the hotbed frame and cover offer some protection and tend to hold the heat accumulated during the day. Another practice in the speeding up of plant production is to cover the top of the rows of the seed bed in the field with a light-weight, black building paper. This paper will absorb much of the sun's rays during the day, consequently transmitting this heat to the seed potato in the row and speeding up plant production. This paper will also protect the row from cold winds and tend to hold the heat in the row. The paper can be removed after the plants come up and danger of frost is over.

TABLE II. Average Minimum Temperatures for the Sweet Potato Areas of Louisiana

| | Length of record in years | Minimum Temperatures | | |
|------------------|------------------------------|----------------------|-------|------|
| | | March | April | May |
| Shreveport | 56 | 48.8 | 56.3 | 63.6 |
| Alexandria | 36 | 49.3 | 55.5 | 62.6 |
| Monroe | 43 | 47.1 | 54.5 | 62.0 |
| Baton Rouge | 43 | 51.7 | 58.0 | 64.1 |
| St. Francisville | 19 | 49.5 | 55.3 | 62.4 |
| Opelousas | 26 | 50.1 | 55.8 | 62.6 |
| Lafayette | 38 | 51.2 | 57.1 | 63.3 |

Manure-heated Hotbeds—Probably the oldest method of supplying heat to a hotbed is the use of fermenting manure. It is still widely

used, but because of the scarcity of a good grade of horse or mule manure, the danger of spreading diseases, and the larger amount of labor required in setting up this type of hotbed, its use on a large scale has rapidly declined. However, for the smaller farmer who has horse or mule manure available it is still a very economical method of supplying heat to a hotbed.

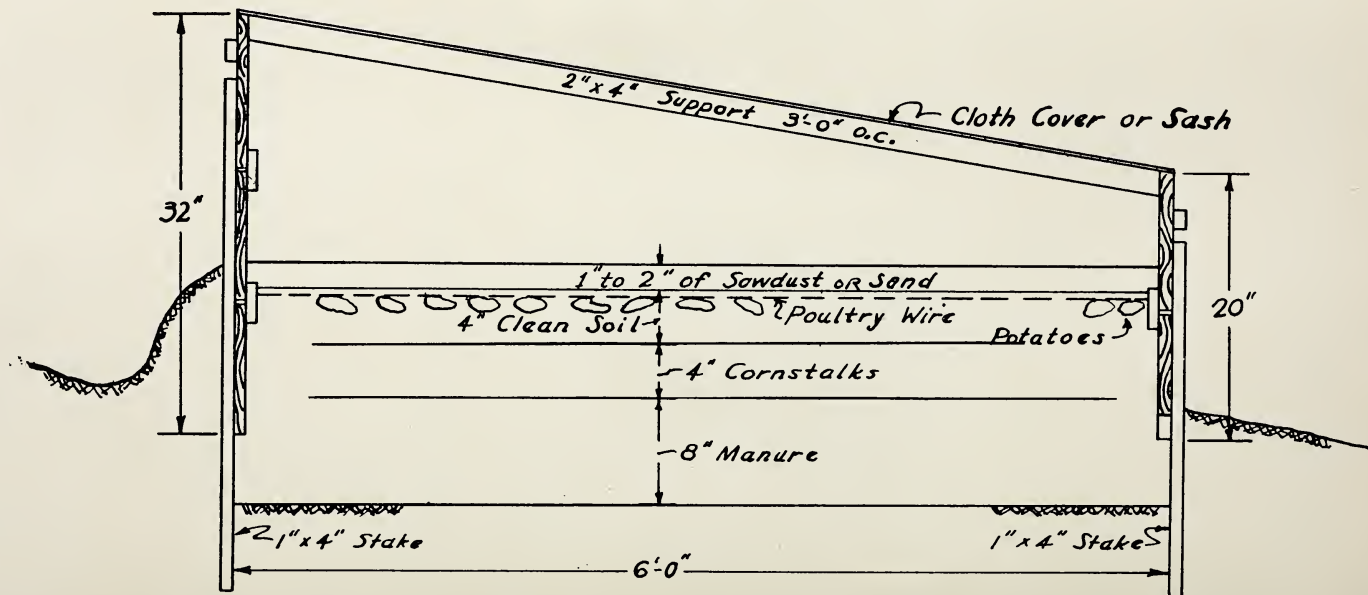
The frame for the manure hotbed can be the same as that used for other types of hotbeds as shown in Figure 2.

The first step in constructing a manure-heated hotbed is to locate a good well-drained spot. The pit should be laid off with a line attached to stakes and then dug to the desired depth. The width and length of the hotbed will be governed by the number of plants needed. A bed 6 to 12 feet should produce enough plants to set one acre of sweet potatoes. If the soil where the hotbed is located is a sandy loam and clean and free of disease it may be used to put back in the bed for bedding the roots in. However, if there is any doubt about its being free of disease it is recommended that new soil be hauled in from a field which has not been planted to potatoes for the past four years.

Manure for use in hotbeds should consist of a good grade of straw bedded horse or mule manure, and should be hauled direct from the stable and not allowed to remain in piles and lose its heating qualities. As it is hauled from the stable it should be placed in broad flat piles alongside the hotbed, where it should remain for 2 to 3 days until it begins to heat. It should then be turned or forked over so as to secure uniform composition and heating. In case the manure is dry and shows a tendency to burn, a little water should be added as it is being turned. As soon as the manure has begun to heat uniformly, which should take about 4 or 5 days, it can be forked into the hotbed pit. It should be spread into the hotbed and watered if dry.

The depth of the manure in the hotbed will depend upon the outside temperature for that locality. For Louisiana, about 8 inches of manure should be sufficient. Figure 2 shows a cross section view of a manure-heated hotbed showing placement of manure, soil, potatoes and cover.

Chopped cornstalks can be used as a substitute for manure if such becomes necessary. The cornstalks used for this purpose should be gathered early as possible in the fall, after the corn has been picked, and stored where they will be protected from the weather. When the hotbed is ready to be prepared, the cornstalks are run through a silage cutter, then moistened and packed in the pit of the hotbed in the same manner as manure. The chopped stalks go through a fermentation process which gives off heat to the hotbed. However, the amount of heat given off by chopped stalks will depend upon the extent to which the stalks have aged before placing them in the hotbed. Under normal conditions the chopped cornstalks can not be expected to give off as much heat as fresh manure, and so a cornstalk-heated bed may be lacking in heat if a long cold spell develops.



CROSS SECTION

Black rot is the major disease affecting Louisiana's sweet potato crop and it can be readily spread through using contaminated soil and manure in a hotbed. It is believed that diseases are so easily spread through the use of manure in hotbeds that many agricultural workers discourage the use of manure as a source of heat for sweet potato hotbeds. However, if it is necessary to use it as a source of heat for hotbeds, all precautions for cleanliness should be taken to avoid disease spread, and the bedded roots should never be allowed to touch the manure. It should be remembered that a manure-heated bed involves considerably more labor in preparation than other types, such as electrically heated beds; however, it requires no more labor in tending than other types and less than the flue-heated beds.

Flue-heated Hotbeds—Fuel-heated beds of various types have just about replaced all of the manure-heated beds, especially in sections where fuel is cheap and the supply of manure is limited. Probably the oldest of the fuel-heated beds is the flue-gas heat. There are a number of ways in which the hot flue gases can be used to heat up a hotbed. Figure 3 shows a typical two-ditch, flue-type hotbed. Referring to Figure 3, it should be noted that the sides and frame of this flue-heated hotbed are made of 1 by 12 inch boards and 2 by 4 frame work. The 2 by 2 rafters for holding the cover are usually on 4 foot centers. Heavy cloth muslin is usually the cover used on this type of bed but they can be laid out for using glass sash just as well. The two-ditch type will vary in width from 7 to 9 feet and is usually 30 to 40 feet long. The flue hotbed is located on the side of a sloping hill preferably having a drainage ditch at the lower end for the starting of the fire box and to eliminate the danger of flooding the fire chamber during rains. The flue ditches are dug up the hill and covered with green wood slabs as shown in Figure 3. A clay soil is placed over the slab about 9 inches deep at the furnace end and about 4 inches deep at the smokestack end. About 6 inches of good sandy loam top soil is placed in the bed for bedding the roots. The smokestack is usually 8 by 8 or 10 by 10, made of lumber or pipe, extending 5 to 6 feet above the surface of the ground. The fire box located at the lower end of the bed is usually made of three old 50-gallon steel oil barrels with each end cut out. A piece of sheet iron held in place by an iron bar is used as a front door for the furnace. When an extremely slow fire is desired a flat block is laid partly over the chimney. Chunks of wood about 18 inches in length and 6 to 10 inches in diameter are used as fuel, and green sawdust is frequently placed on top of the wood in the furnace to give a slow-burning or smoldering fire. According to growers using this type of bed it will require about one cord of wood for each bed during a plant growing season. These flue fire boxes will require tending 2 to 3 times a day.

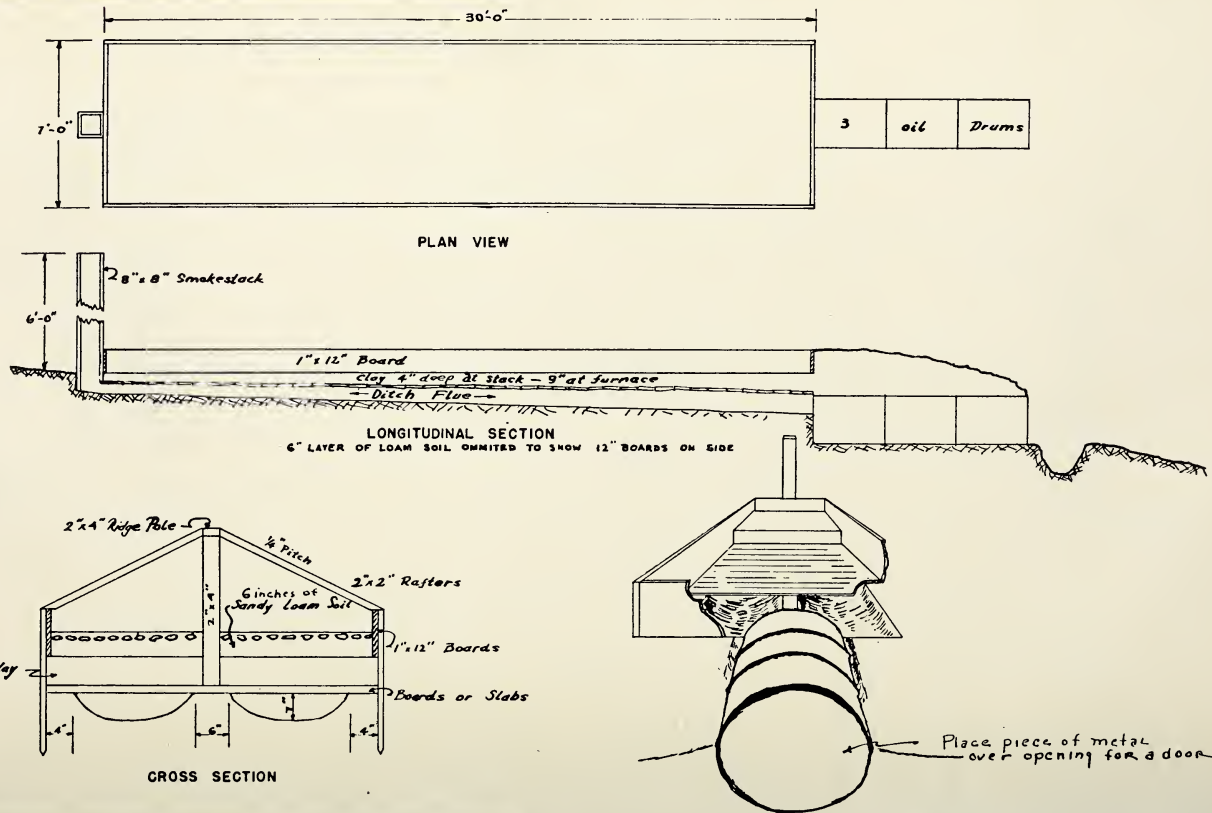


FIG. 3.—Plan for a Two-ditch Type of Flue-heated Hotbed.

Figure 4 shows a typical single-ditch hotbed. These are usually 6 feet wide and not over 50 feet long. Old roofing metal, etc. can be used to place across the flue ditch provided some old pipe or iron is placed across the ditch about every 2 or 3 feet under the metal.

Provided wood is plentiful and labor is available at a low cost, the flue-heated hotbed can be an economical method of growing sweet potato plants on a large scale. It is probably lower in first cost to build,

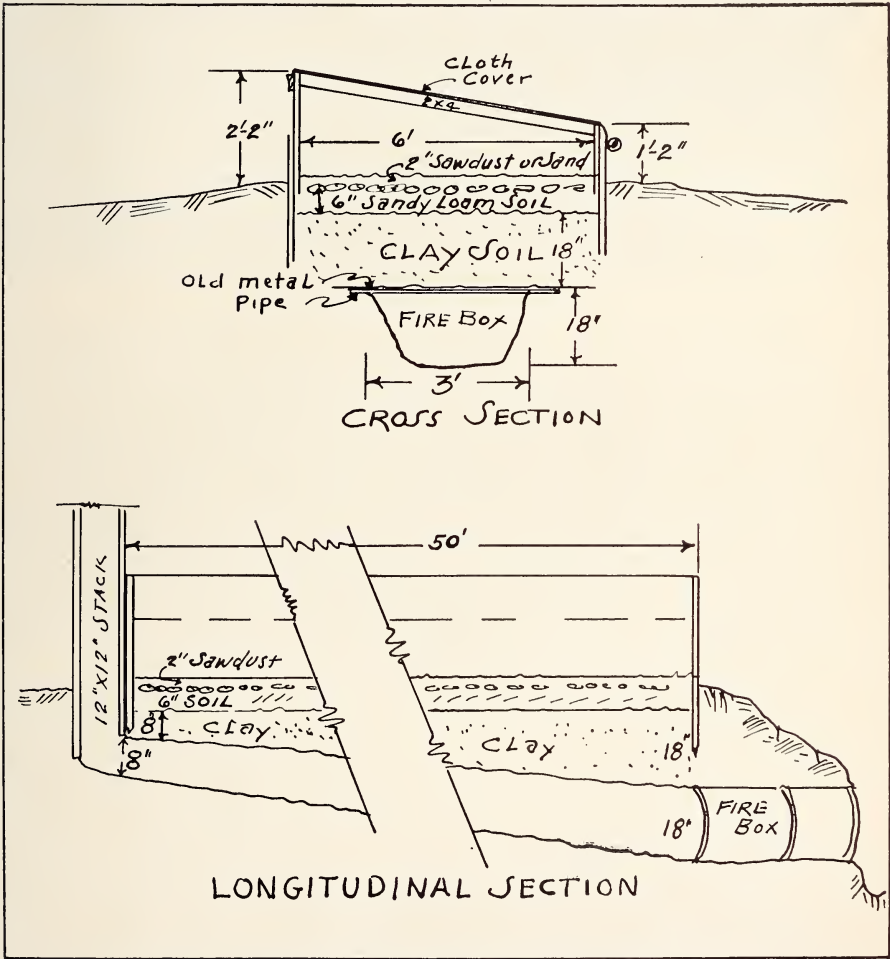


FIG. 4.—Details of a Single-ditch, Flue-heated Hotbed.

since controls, pipe, wire, etc. are not used, as compared to the electric and hot water hotbeds. Some of the disadvantages of using this method of heating hotbeds are as follows: requires more labor for constant tending of the fires during cold weather; greater temperature fluctuation in the hotbed due to unsteady fire, must be on a large scale to make operation economical.

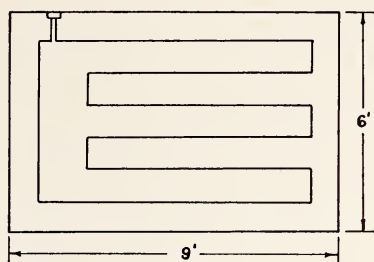


FIG. 5.—Flue-heated Hotbed.

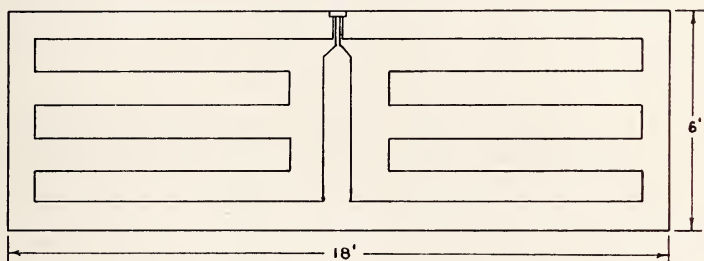
Electrically Heated Hotbed—A special flexible electric soil-heating cable has fast become the most popular method used in Louisiana for heating hotbeds. This popularity of the soil-heating cable can be attributed to several factors. One is that recently electricity has been made available to practically all farmers. Electrically heated hotbeds are thermostatically controlled and therefore require very little tending; at the same time, the hotbed maintains a very constant heat even with fluctuating outside temperatures. They require less labor to construct and no fuel has to be hauled and no firing done. It is probably the best suited method for heating a small bed for the farmer who wants to put in one 6 by 9 or 6 by 18 feet bed as shown in Figure 6.

The soil heating cable consists of a high resistance conductor covered with felted asbestos, varnished cambric, and a protective lead sheath. Owing to its electrical resistance it must always be used in a 60-foot length on 115 volt circuit and a 120-foot length on a 230 volt circuit. The 60-foot length is rated at 400 watts and the 120-foot length is rated at 800 watts. Results of tests under Louisiana conditions show that about 7 watts per square foot is all the heat necessary for growing sweet potato plants in a hotbed. Based on this figure for heat requirement and the standard lengths of electric cable, 60 feet for 115 volts and 120 feet for 230 volts, three sizes and placement of electric heating cable for each size are shown in Figure 6. Some companies now have available soil heating kits which consist of one soil thermostat with plug receptacle attached and one or two 60-foot lengths of heating cable. The heating cable in this case will have a heavy duty male plug on the end for plugging into the receptacle. Figure 10 shows the standard kit unit plus a switchbox.

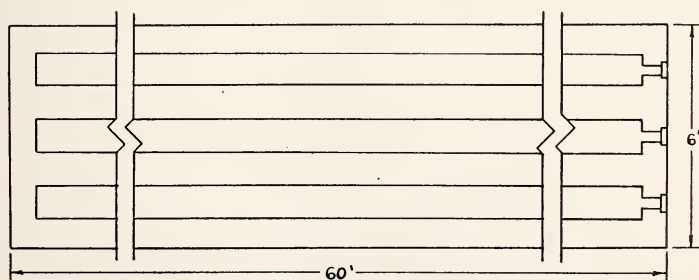
For large installations where much of the heating cable is to be



ONE 60' CABLE - 115 VOLTS



TWO 60' CABLES - 115 VOLTS



THREE 120' CABLES - 230 VOLTS

FIG. 6.—Three Sizes of Hotbeds Showing Placement of Standard Lengths of Electric Heating Cable.

used it is more economical to buy the heating cable in bulk quantity in multiples of 60 or 120 feet. The bed can then be wired by the farmer or an electrician in a manner shown in Figure 9. By knowing the load for each length of cable, the proper size wire for handling the bed can be obtained from Table III.

The general construction of the hotbed frame and suitable size for locating the hotbed are the same as covered in previous paragraphs under those topics.

It is known that the roots produce the maximum amount of plants when held between 83° F. and 85° F. Therefore, in order to maintain an even temperature at the level of the roots in a hotbed, the heating cable should be placed at a definite depth below the roots for a given spacing. Studies on this subject were conducted under controlled conditions in the laboratory and results of the tests indicate that a uniform temperature in the hotbed at the level of the bedded roots can be obtained if the following ratio of cable spacing and depth of cable below roots is followed: for a cable spacing of 10 inches, distance of cable under roots should be 3 inches; for a cable spacing of 12 inches, distance of cable under roots should be 4 inches; for a cable spacing of 14 inches, distance of cable under roots should be 5 inches.

TABLE III. Wire Size to Use in Running 115 and 230 Volts Extensions Varying in 100-Foot Lengths, from Metering Point to Hotbeds of Sizes Shown. These are the Sizes of Wires Required to Keep the Voltage Drop Below the Maximum Allowed for Economical Operations.

| Length of Soil Cable In Feet | DISTANCE — FEET | | | | | | |
|------------------------------------|-----------------|-----|-----|-----|-----|-----|------|
| | 100 | 200 | 300 | 400 | 500 | 750 | 1000 |
| Wire Size Required | | | | | | | |
| 115 VOLTS | | | | | | | |
| 60 | 10* | 10* | 10* | 10 | 10 | 8 | 8 |
| 120 | 10* | 10* | 10 | 10 | 8 | 6 | 4 |
| 180 | 10* | 10* | 8 | 8 | 6 | 4 | 4 |
| 230 VOLTS | | | | | | | |
| 240 | 10* | 10* | 10* | 10 | 8 | 8 | 6 |
| 360 | 10* | 10* | 10 | 8 | 8 | 6 | 6 |
| 480 | 10* | 10* | 10 | 8 | 8 | 6 | 4 |
| 600 | 10 | 10 | 8 | 8 | 6 | 4 | 4 |

* Minimum size allowed by National Safety Code for outside overhead conductors.

Figures 7 and 8 show cross section views of a standard 6-foot and 10-foot electrically heated hotbed. These figures show the recommended insulating layer between the cable and the ground, the spacing of the heating cable, and distance for bedding the roots above the cable. The sawdust or sand layer above the roots prevents a crust from forming and makes pulling slips much easier. The poultry wire above the roots is to prevent disturbing the roots when pulling slips.

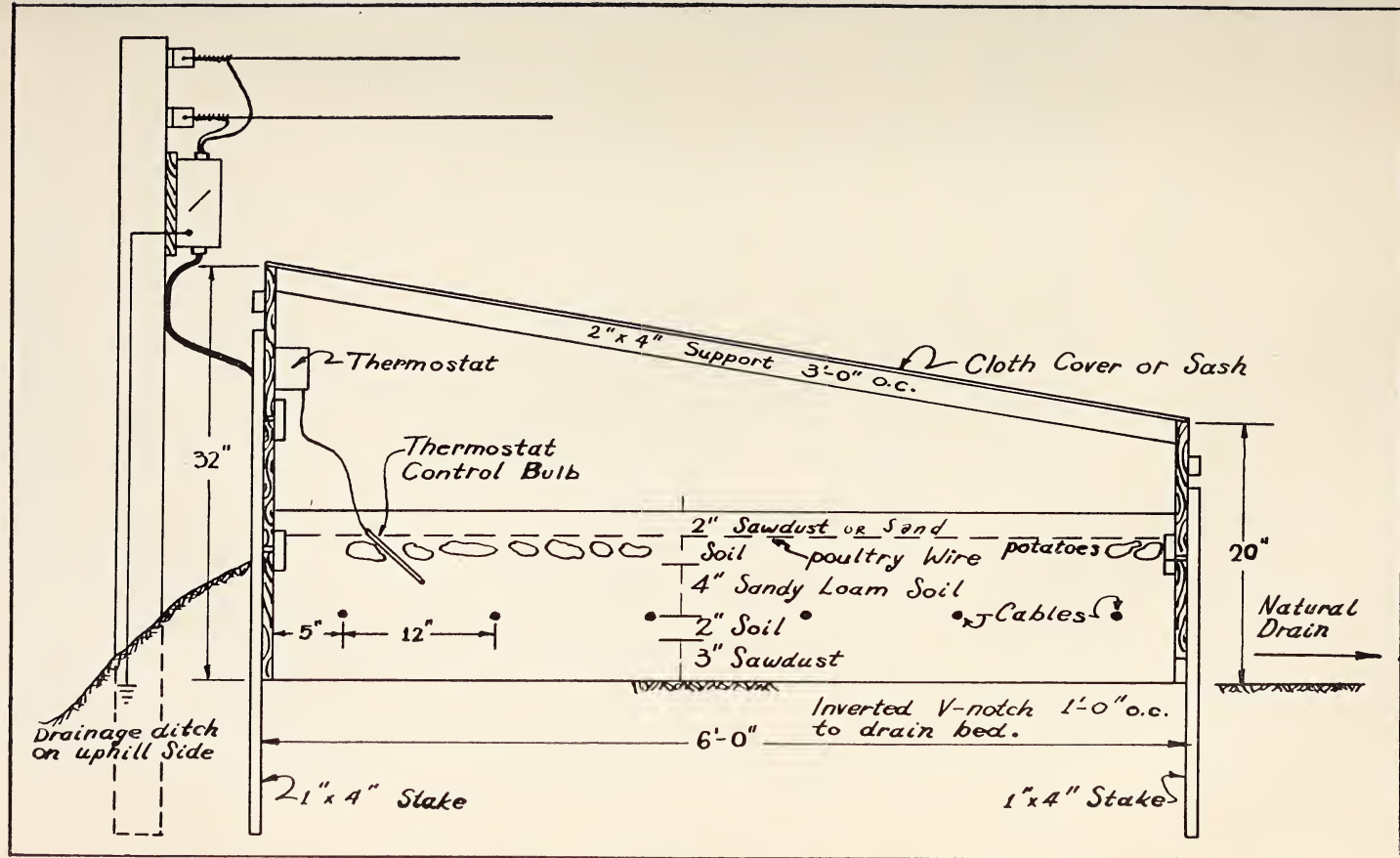
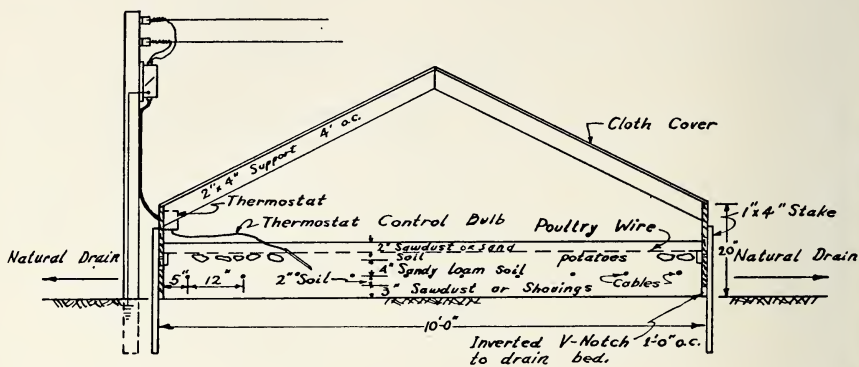
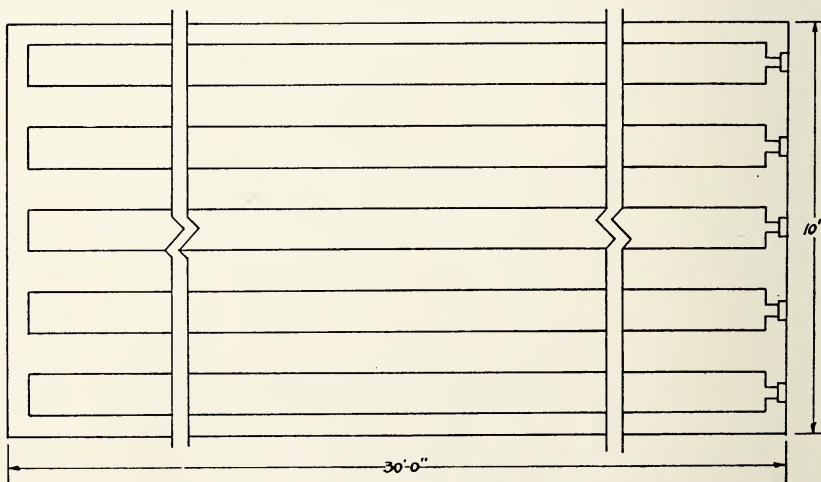


FIG. 7.—Cross Section View of a Typical Sash or Cloth Covered Hotbed.



CROSS SECTION



FIVE 60' CABLES - 115 VOLTS

FIG. 8.—Cross Section Detail and Electric Heating Cable Layout for the Wide Type of Hotbed Used by Commercial Plant Growers.

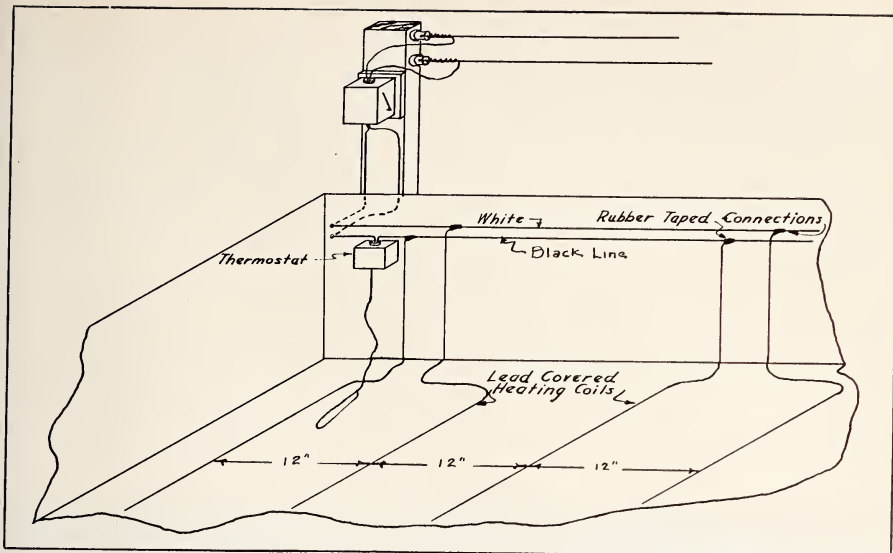


FIG. 9.—Wiring Connections for Electric Cable-Heated Hotbed.

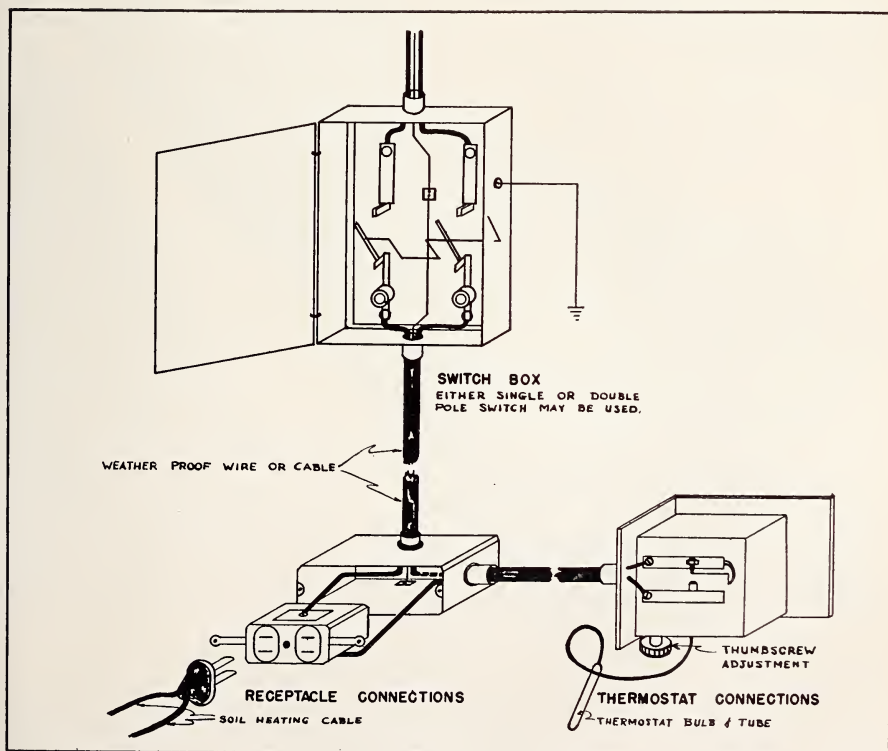


FIG. 10.—Wiring Connections for an Electric Cable-Heated Hotbed Showing Thermostat, Switch Box and Receptacles.

All precautionary measures as to using clean disease-free soil for bedding the roots, etc., as discussed under manure-heated beds also applies here. If the hotbeds are to remain in the same location year after year, then the bedding soil down to the heating cable should be removed and replaced with fresh soil at the time of bedding in the roots in spring. In removing this soil it is very easy to cut or damage the heating cable, causing faulty operation. To eliminate this damage many operators have covered the cable with half-inch mesh hardware cloth. Damage from cable cutting can be very expensive.

The thermostat plays a very important part in the hotbed operation. It is the instrument that keeps the hotbed at the proper temperature. If its operation is faulty, serious damage might result to the roots in the hotbed. It is recommended that the thermostat be tested each spring before the hotbed is put into operation. The method used for properly adjusting the thermostat is discussed in a later paragraph under "Operating the Hotbed."

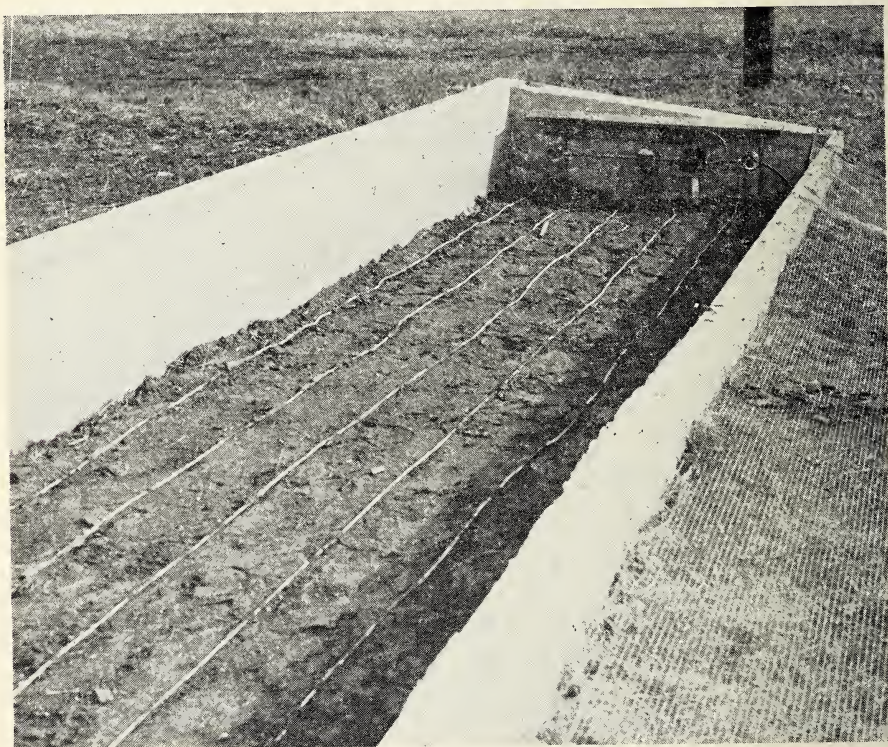


FIG. 11.—Electrically Heated Hotbed Showing Electric Heating Cables in Place.

Results of tests on the operation of electrically heated hotbeds indicate that for average conditions electric heat is supplied to a hotbed for a period of 10 to 14 hours each day. As would be expected, this heat is supplied during the night and practically all day on dark days.

Data taken on the electricity used on a number of hotbeds for the past several seasons show that the average consumption of electricity for the period of operation is from 4.5 to 6.5 kw/h per square foot of hotbed surface. The period of operation is usually 6 to 7 weeks.

The use of electric light bulbs is another method by which electricity is used to heat the hotbeds. This method has become particularly popular for small installations such as from one to three beds. If properly installed, the electric light bulb installation is no cheaper in first cost than the electric cable hotbed. However, the ability to procure the bulbs and sockets at the local store, when needed on short notice, has probably been a deciding factor many times. The electric heating cable is not usually stocked by the local dealer and so entails a delay in ordering. If electric bulbs are to be used the wattage per bulb should not be larger than 50 watts. This is advisable so as to get an even distribution over a greater surface and not tend to concentrate too much heat under one bulb, which is highly possible if a large wattage were used. The wattage per square foot should be figured as 7 watts, the same as for the cable, and the number of bulbs necessary to cover the hotbed spaced as evenly as possible. The bulb sockets and electrical connections should be weather proof to prevent shorting out while watering the beds. It is advisable to cut off the electricity to the hotbed while watering. Figure 12 shows a sweet potato hotbed equipped with 25-watt electric bulbs as a heating source. Test data collected over several years indicate that there is practically no difference in the electricity consumed for heating between beds using heating cable and those using the light bulbs. Some research workers feel that after the plants are up the electric light bulb offers additional stimulation to plant growth. The use of light bulbs



FIG. 12.—Hotbed Using 25-Watt Electric Bulb as a Source of Heat.

as a source of heat has become popular for cold frame beds when heat is needed. These are usually connected up without use of thermostat and turned on by the operator only when he decides some heat to the cold frame is advisable.

Some of the disadvantages of using electric bulbs are as follows: high breakage of the electric light bulbs; in the way for both watering and pulling plants; must be disconnected and removed for cleaning the beds at end of each season; and requires storage space when not in use.

Hot Water-heated Hotbed—The use of hot water circulated in pipes buried in the soil of the hotbed has been gaining in popularity for large-scale commercial operators. The frame of the hotbeds using this method for heating is usually the wide gable cover type as shown for the electric bed in Figure 8. The building of the frame and placement of soil, etc., are the same for the hot-water system as have been described for the electric cable system. The only difference is that half-inch pipes are placed where the electric cables are shown in the drawing. The hot-water beds are usually 60 feet long and another bed is set behind the first so that the hot-water pipes can run the full length of the two beds before returning. Figure 13 is a schematic diagram showing all the components that go to make up a hot water-heated system. The principle of operation is briefly as follows: Water is taken from the open surge tank by the electrically driven centrifugal pump and forced under pressure through the heating coils, where the water is heated; it is then forced into the hot-water header line, which is a large line that runs at the head of each row of hotbeds; from this header line half-inch pipes run the length of each of the two beds, then turn on a one-foot radius bend and return to the head of the two beds where they empty into a cold-water header line and return to the open water surge tank to be pumped again through the system. The duration of operation is controlled by a thermostat just as in the electrically heated system. However, in this case the thermostat makes an electrical connection when the beds become cool, which allows the electric motor to start pumping and at the same time opens a magnetic valve that starts the gas burner to burning under the water coils. When the beds are warm enough, according to the setting of the thermostat, the electrical connection is broken, thereby stopping the electric pump and shutting off the gas burner.

The discharge and return pipes in the hotbed can be one-half-inch regular screw thread or copper pipe and are spaced 12 inches apart as shown in Figure 8. The header lines running at the head of the beds are $1\frac{1}{4}$ or $1\frac{1}{2}$ inch pipe.

The amount of heat supplied the hot-water beds is the same as for the electrically heated beds but is quoted on a BTU basis, which is a standard measurement of heat when dealing with fluids. For the electric beds, 7 watts of electric heat per square foot was the basis for arriving at the required heat. Since 1 watt is equal to 3.412 BTU, the heat load for the hot-water bed will be 7×3.412 , or 23.884 BTU per square foot

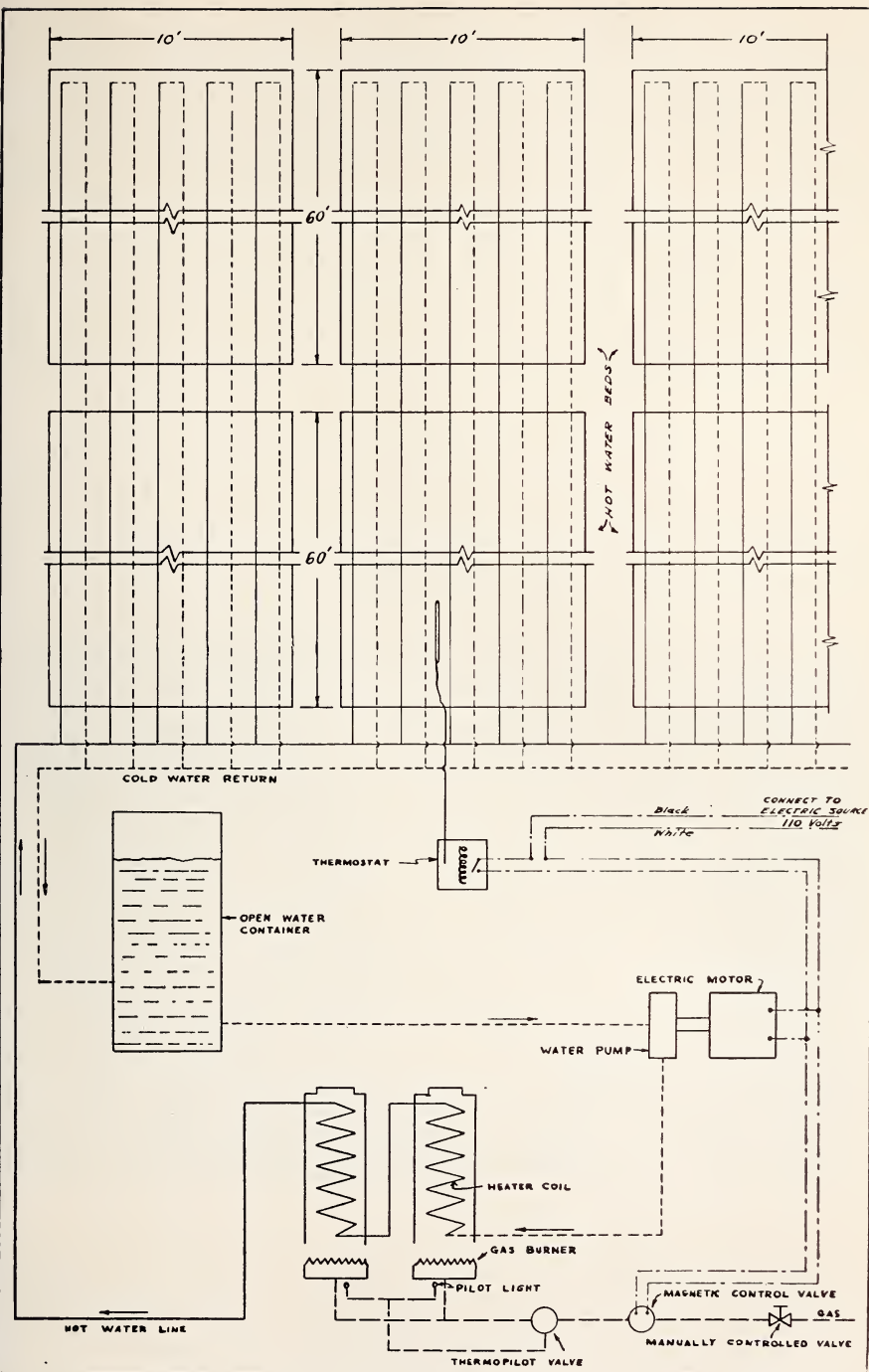


FIG. 13.—Layout Diagram for a Six-Bed, Hot Water-heated Hotbed System.

of bed. By taking the total area of the hotbeds and multiplying that by 23.884 the amount of heat necessary for the installation can be figured. It is wise to allow approximately an additional 4 to 5 per cent of heat requirement to compensate for the heat lost in the header lines.

The hot-water coil heaters together with the gas burners can be obtained from a number of hot-water heater manufacturers. These are given a BTU rating so that the desired size can be obtained. These units are compact, easy to install, and fairly efficient.

It is possible for a farmer to make his own heater coil by coiling the correct length copper pipe and mounting it in a suitable size drum, but some skill is required in turning a good coil without forming a sharp kink which would retard the flow of water. Figure 14 shows a home-made heating coil and gas burner installation in a 50-gallon oil drum and the electric centrifugal pump for circulating the water.

Using as an example the hot water-heated hotbed installation as shown in Figure 13, sample determinations will be made for selecting the size of heating system and motor-pump unit. The total area of the six beds will be 3,600 square feet. Using the round figure of 24 BTU per square feet as arrived at in a previous paragraph, the necessary heat to be supplied the hotbed will be 86,400 BTU per hour. Allowing

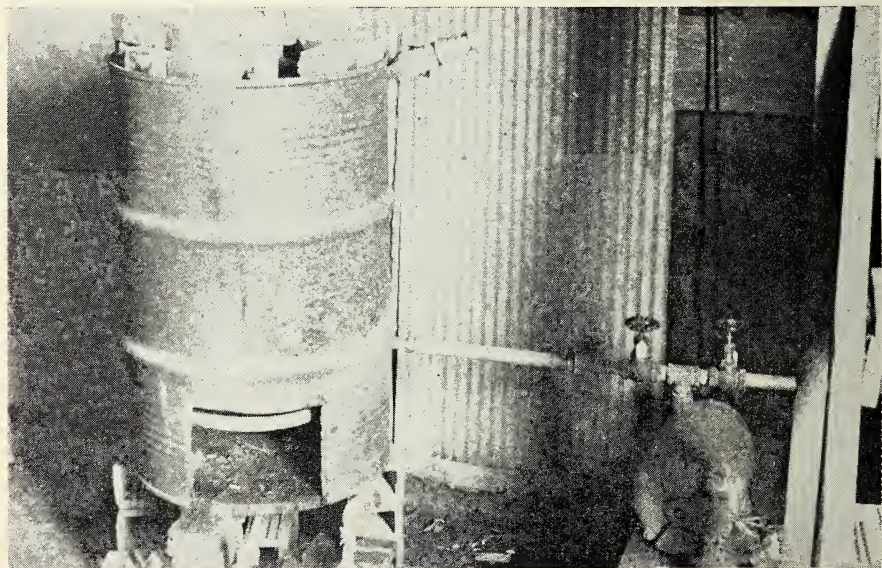


FIG. 14.—Coil Heater and Pump for a Hot Water-heated Hotbed.

3,600 BTU for heat loss in the header line will bring the total heat necessary to 90,000 BTU per hour. This heat will have to be supplied by the circulating water. From previous experience it is known that the temperature drop in the lines in a hotbed of this length should be about 14 to 16 degrees F. for sweet potato plants. The thermostat should be set so that the mean temperature between high and low is about 83

degrees F. This means that approximately 11 gallons of water per minute must be circulated against a friction head of about 78 to 80 feet.

From a pump catalog a three-fourth inch centrifugal pump capable of 10 to 15 gallons per minute operating at a head of 80 feet can be selected. This pump is driven directly by a three-fourth H.P. electric motor. It is definitely recommended that the motor-pump unit be direct driven, as a belt driven unit may cause damage in the event the belt breaks.

From a heater company catalog select a coil heater whose capacity in BTU output of heated water equals the calculated heat required for the hotbed system. It is often necessary to use two heaters as shown in Figure 13. In this event it is recommended that the heaters be connected in series so that all the water circulated must pass through the coils of both heaters.

The chief advantage of this hot-water system is the low cost of operation due to the plentiful source of cheap natural gas in Louisiana. The first cost of the pump, heater coils and pipes makes it the most expensive system to set up, but according to operational results kept for the past several years this high first cost is quickly offset by the low operational cost for a large hotbed system. It requires the same amount of labor for tending as the electric heating system. It has a low replacement or upkeep cost, as the pipes are never damaged when replacing the soil in the hotbed as is sometimes the case for the electric heating cable. Its chief disadvantage is that it cannot be installed on a small size hotbed, since the smallest motor-pump unit and coil heater is too large and expensive for a small installation.

OPERATING THE HOTBED

Thermostat Adjustment—When using electric cable, electric lights or circulating hot water, the thermostat is the instrument that keeps the bed at the proper temperature. It should be checked before putting the bed into operation each spring. Some thermostats have degree markings on the adjustment screw dial. It should never be taken for granted that these graduations are correct until proven by testing. The temperature setting can be adjusted in the following manner: Place the thermostat bulb in a container of water which is 85° F. as measured by a reliable thermometer. At this temperature the electrical contacts should separate or be adjusted to separate. Then place the bulb in water at 80° F. and the contacts should come together again. For adjusting the setting the adjustment screw on the thermostat can be turned counter-clockwise to raise the temperature and clockwise to lower the temperature setting. When the proper thermostat setting has been determined, the bulb should be placed in the bed at the same level as the potatoes. A thermometer should be inserted in the bed to the depth of the potatoes and preferably located so that it can be read without disturbing the cover. The thermometer should be read daily to ascertain that the bed is heating properly. After the heat is turned on, the bed should warm up to 80 to 85° F. in a couple of days.

Cover—It is necessary to have cloth, glass, or glass substitutes to cover the bed at night if economical operation is expected. In order to conserve fuel the cover should remain over the bed during cool, cloudy days.

Watering—The bed should be watered after the potatoes have been placed in the bed, and watering thereafter will depend upon type of heat and weather conditions, but frequency of watering will be from once to twice a week.

Ventilation—When the sprouts begin to appear in the hotbed the cover will have to be rolled back from the beds on bright sunny days from about nine in the morning until about five in the afternoon. If the cover is left over the bed during a hot, sunny day the plants may become scorched. After the plants become older the heat may be turned down and the cover left off to harden the plants before pulling for field setting, but danger of frost must be watched.

Storage—When the hotbed season is over a little attention given the beds can prove a big saving over a period of years. If a cloth cover is used, it can be made to last several seasons if it is dried out, rolled up, and stored away in a dry place. The potato bedding soil should be removed and the bed aired until ready for refilling the next season. Electricity should be cut off from the bed and the thermostat stored out of the weather in the case of the electric or hot water-heated beds.

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ACKNOWLEDGMENTS

The author wishes to acknowledge the valuable help of Mr. E. A. Hodge and Mr. Garland O. Edelen, of the Louisiana Power and Light Company, for assistance in collecting data on electrical hotbeds; Mr. F. B. Fields and Mr. J. P. Fields, of Fields Seed and Plant Company, for their cooperation in supplying data on hot-water beds; and Mr. John Cox of the Louisiana State University Agricultural Extension Division for his guidance in the horticultural phase as related to this work.